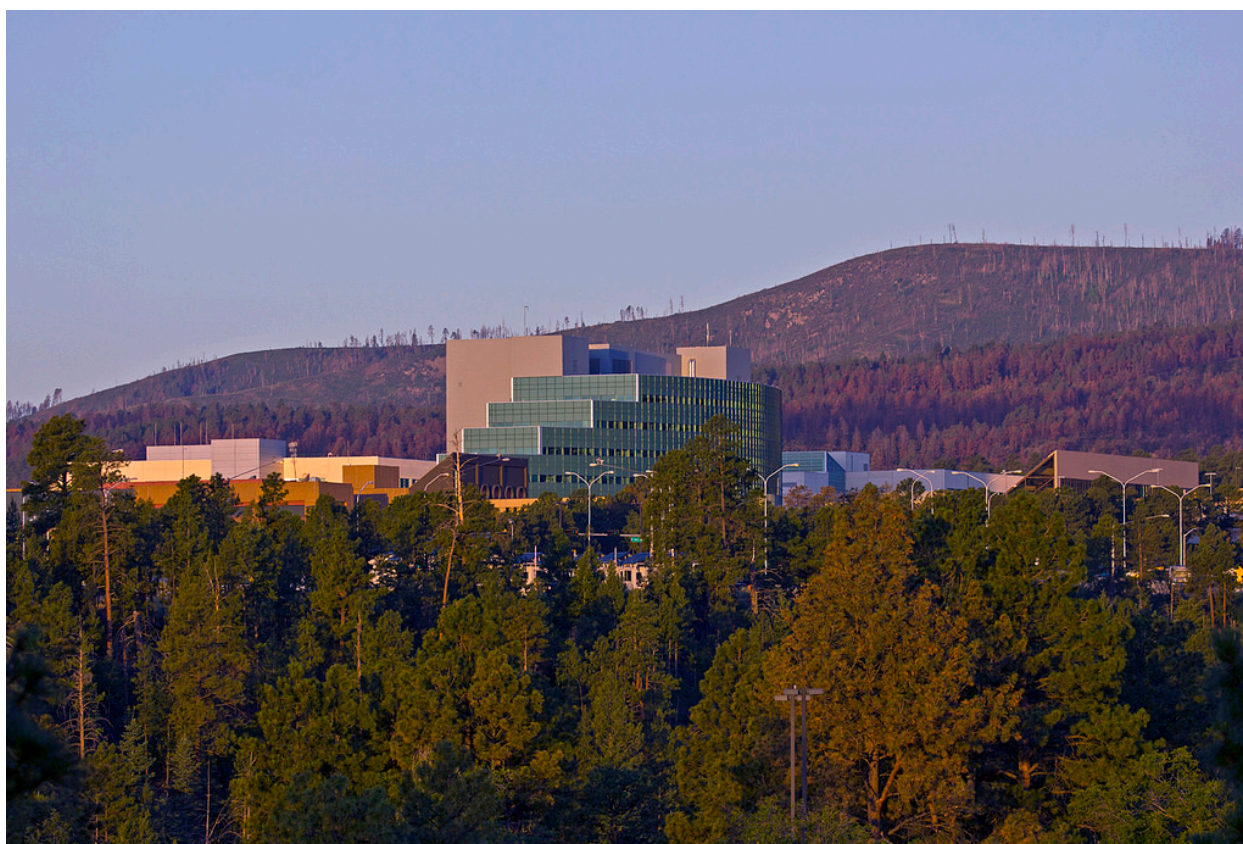




Scientists use world's fastest computer to understand nonlinear physics of high-power lasers

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To achieve fusion scientists must put as much laser energy on target as possible, a task complicated by energy loss due to laser backscatter, or reflection

Los Alamos, New Mexico, Oct 28, 2009—For years scientists have struggled with the difficult physics of inertial confinement fusion. This is the attempt to compress a target capsule containing isotopes of hydrogen with high-powered lasers to high enough pressure and temperature to initiate fusion burn.

To achieve fusion scientists must put as much laser energy on target as possible, a task complicated by energy loss due to laser backscatter, or reflection. Fusion is the basic

energy-producing process of the sun, and is a source of energy released by nuclear weapons.

Los Alamos scientists Lin Yin and Brian Albright of Applied Science and Method Development, along with Los Alamos guest scientist Kevin Bowers, are using an adapted version of VPIC, a particle-in-cell plasma physics code, on Roadrunner to model the nonlinear physics of laser backscatter energy transfer and plasma instabilities to assist colleagues at Lawrence Livermore National Laboratory as they attempt to reach fusion ignition at the National Ignition Facility (NIF) next year.

“These are the largest plasma simulations ever done, looking at 0.4 trillion particles on the whole system,” said Lin. “It would not be possible to do this without a petascale computer like Roadrunner, but even so, we are still only looking at a tiny segment of a laser beam.”

VPIC is a computer code that models plasma at very high resolution, so even with Roadrunner it cannot simulate nonlinear backscatter in a full laser beam. “And so we focus on a single ‘hot spot’ in the laser beam to see if we can determine how the energy loss happens and what the nonlinear process is,” said Lin.

Energy loss from laser reflectivity depends on laser intensity. This behavior has been observed in Roadrunner simulations and experiments using the Trident Laser at Los Alamos.

“We can use this physics understanding to infer energy loss from the whole beam and aid the experimental design,” said Lin. “Using Roadrunner, we now understand why it’s happening in the first place, how laser energy couples to this instability, and what limits the backscatter. We believe that this work will help ensure the success of NIF.”

About Roadrunner, the world’s fastest supercomputer, first to break the petaflop barrier

On Memorial Day, May 26, 2008, the “Roadrunner” supercomputer exceeded a sustained speed of 1 petaflop/s, or 1 million billion calculations per second. “Petaflop/s” is computer jargon—peta signifying the number 1 followed by 15 zeros (sometimes called a quadrillion) and flop/s meaning “floating point operation per second.” Shortly after that it was named the world’s fastest supercomputer by the TOP500 organization at the June 2008 International Supercomputing Conference in Dresden, Germany.

The Roadrunner supercomputer, developed by IBM in partnership with the Laboratory and the National Nuclear Security Administration, will be used to perform advanced physics and predictive simulations in a classified mode to assure the safety, security, and reliability of the U.S. nuclear deterrent. The system will be used by scientists at the NNSA’s Los Alamos, Sandia, and Lawrence Livermore national laboratories.

The secret to its record-breaking performance is a unique hybrid design. Each compute node in this cluster consists of two AMD Opteron™ dual-core processors plus four PowerXCell 8i™ processors used as computational accelerators. The accelerators used in Roadrunner are a special IBM-developed variant of the Cell processor used in the Sony PlayStation 3®. The node-attached Cell accelerators are what make Roadrunner different than typical clusters.

Roadrunner is still currently the world’s fastest with a speed of 1.105 petaflop/s per second, according to the TOP500 announcement at the November 2008 Supercomputing Conference in Austin Texas, and it again retained the #1 position at the June ISC09 conference.

Los Alamos National Laboratory

www.lanl.gov

(505) 667-7000

Los Alamos, NM

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